

E 7.5 - 1 0.2 59

CA 142635

Quarterly Progress Report, June - August 1974

SKYLAB EREP Investigation 475, Contract Number NAS 9-13406

INTERDISCIPLINARY APPLICATION AND INTERPRETATION OF
EREP DATA WITHIN THE SUSQUEHANNA RIVER BASIN

"Made available under NASA sponsorship
in the interest of early and wide dis-
semination of Earth Resources Survey
Program information and without liability
for any use made thereof."

Office for Remote Sensing of Earth Resources (ORSER)
Space Science and Engineering Laboratory (SSEL)
Room 219 Electrical Engineering West
The Pennsylvania State University
University Park, Pa. 16802

Principal Investigators: Dr. George J. McMurtry and
Dr. Gary W. Petersen

NASA Technical Monitor: Mr. Martin Miller

September 1974

(E75-10259) INTERDISCIPLINARY APPLICATION
AND INTERPRETATION OF EREP DATA WITHIN THE
SUSQUEHANNA RIVER BASIN Quarterly Progress
Report, Jun. - Aug. 1974 (Pennsylvania State
Univ.) 6 p HC \$3.25 CSCL 08P G3/43

N75-22870

Unclas
00259

Quarterly Progress Report

June - August 1974

SKYLAB EREP Investigation 475
Contract Number NAS 9-13406

RESEARCH ACTIVITIES

The mapping of well locations on aircraft photography is continuing, in the study of the significance of lineaments to groundwater exploration and engineering problems. These wells are being ranked according to their location on or off of fracture traces (lineaments less than one mile in length) and fracture trace intersections. This work is a prelude to the location of wells with respect to lineament identification on SKYLAB and ERTS images. It is proposed that the field location of wells with respect to lineaments can be narrowed down by going from ERTS-1 to SKYLAB levels of observation, SKYLAB to U2, U2 to lower altitude aircraft data, and/or U2 to ground or SKYLAB to ground data. The study regions, in central Pennsylvania, include Nittany, Penns, and Brush valleys; Bald Eagle Valley between Hollidaysburg and Milesburg; and a tributary drainage to the Susquehanna River near Selensgrove.

SKYLAB 4 S190A photographs (Roll 55, Frame 317) have been used to verify suspected associations of lineaments with known ground water movements. Increased yields have been associated with water wells located on lineaments as compared with adjacent sites. These correlations are continuing.

The bulk of the field work along Bald Eagle ridge, west of State College, was performed during this period. Analysis of the data gathered will serve to characterize the surface expression of the large lineaments intersecting the ridge.

Further investigation is being made into the thermal hot spot phenomenon near Shermansdale. The hot spring is readily discernible on thermal IR data, and subtle tonal variations in high altitude images (U2) indicate that the hot spot is on the periphery of a large (30 km diameter) circular feature that appears to coincide with a major (500 gamma) magnetic anomaly believed associated with a deep pluton not previously recognized in Pennsylvania. Alternative associations can be made with lineaments, seen on SKYLAB 3 photography (S190A, Roll 44, Frame 30), that pass through the hot spot area, and possibly with diabase dikes that crop out in the vicinity.

The ORSER program SUBSET has been modified to subset from SKYLAB tapes, when these are received. As they now stand, SUBSET will subset data from ERTS and SKYLAB data tapes into ORSER format, and SUBAIR will subset C130 MSS and thermal data, and LARS data.

RELATED ACTIVITIES

Mr. Vargas, Instructor of Environmental Sciences at the Dubois Campus of Penn State, is using SKYLAB, ERTS, and U2 scenes for a land use mapping project of selected areas of Clearfield County. Mr. Bazakas, Assistant

ORIGINAL PAGE IS
OF POOR QUALITY

Professor of Geology at the Ogontz Campus, is using SKYLAB, ERTS, and U2 data in a lineament analysis of southeastern Pennsylvania and New Jersey, with a view toward the location of ore deposits. Mr. Ciciarelli, Assistant Professor of Geology at the Beaver Campus, has begun a study of fracture traces and macro-lineaments in central western Pennsylvania. This study will use SKYLAB, U2, RB57, and C130 data along with field checking of features seen on the scenes. A joint distribution analysis is planned as part of this study. These three projects are conducted under the supervision of ORSER and are funded through the Commonwealth Campus Scholarly Activity Fund of The Pennsylvania State University. This fund is administered by the Dean of Academic Instruction for Commonwealth Campuses.

During this period Mr. Kowalik was on temporary assignment to the EROS program of the U.S. Geological Survey in Reston, Virginia. While there, he worked with the Diazo duplicating process, developing a method of creating ERTS color composites using colored Diazo transparencies of scenes from three of the four ERTS channels. This method has been duplicated on Diazo equipment being considered for purchase by ORSER. Diazo copies have been made of several SKYLAB photographs already, and it is expected that the knowledge of this process gained by Mr. Kowalik will be useful in the analysis and display of SKYLAB data, as well as data from ERTS and aircraft.

Although Dr. Gold was mainly occupied in teaching the Geology field school in Montana this summer, he found time to revise for publication a paper, co-authored by Dr. Melwin H. Podwysocki, "The Surface Geometry of Inherited Joint and Fracture Trace Patterns Resulting From Active and Passive Deformation." This paper has been issued as NASA Preprint X-923-74-222. (A copy of the abstract is appended.) Dr. Podwysocki graduated from Penn State in 1974 and is now on the staff at NASA-Goddard. The ~~title~~ of his thesis was "The Relationship of Fracture Traces to Geological Parameters in Flat-Lying Sedimentary Rocks: a Statistical Analysis." A portion of this thesis was the paper, "An Analysis of Fracture Trace Patterns in Areas of Flat-Lying Sedimentary Rocks for the Detection of Buried Geologic Structure," by Podwysocki and Gold, published by NASA-Goddard as X-923-74-200. (An abstract of this paper is also appended.)

A paper, "Relationship Between Ore Deposits and Lineaments in Southeastern Pennsylvania," was presented by Mr. Kowalik at the First International Symposium on the New Basement Tectonics, in Salt Lake City, Utah, in June. This same paper was presented by Mr. Kowalik to the Graduate Student Colloquium at Penn State in May.

Dr. Gold prepared a slide show, "ERTS-1 and SKYLAB," and exhibit for the Earth and Mineral Sciences Exposition at Penn State. He also gave a lecture on "Megalineaments and the Distribution of Alkaline Rocks, Kimberlites, and Carbonatites," at Wayne State University, Detroit, Michigan. This talk featured scenes from both SKYLAB and ERTS.

ORIGINAL PAGE IS
OF POOR QUALITY

DATA FLIGHTS AND RECEIPTS

During this period the following data were received relating to the SKYLAB program:

SL 3, S190A 9 inch photography
SL 3, S190B 5 inch photography
SL 3, S192 5 inch MSS scanning film in 2 channels
S1 4, S190A 70mm photography
SL 4, S190B 5 inch photography

ORIGINAL PAGE IS
OF POOR QUALITY

THE SURFACE GEOMETRY OF INHERITED JOINT AND FRACTURE TRACE PATTERNS
RESULTING FROM ACTIVE AND PASSIVE DEFORMATION

M. H. Podwysocki and D. P. Gold

ORIGINAL PAGE IS
OF POOR QUALITY

ABSTRACT

The surface traces and trajectories of "joints" and "fractures" located over simple subsurface structures, with configurations optimized to a horizontal cylinder and vertical hemisphere and combinations thereof, are examined for two hypothetical methods of fracture development. The models are generated for a "rubber sheet" deformation and assume (a) that a fracture system may be inherited from the basement rocks through any overlying consolidated sediment, (b) that these fractures would be deformed by any subsequent movements in the basement rocks, (c) that in any kinematic folding, these fractures would be rotated and displaced by a flexural slip mechanism, and (d) that for supratenuous folds, any fractures developed during compaction would be focused through the center of curvature. It is asserted that (a) the inherited fractures, while being rotated and displaced by the bedding plane slip, would project vertically to the surface, i.e., orthographically, and (b) that fractures induced during compaction would converge upward in a down-warp or diverge in an upwarp from a focal point in the case of a dome or basin (periclinal structure) and a focal line for a supratenuous fold, and that these would project gnomonically to the surface. While the former mechanism is considered to be "active" and may be generated by local basement uplifts, the latter is "passive" and is typified by differential compaction of sediments over a reef core.

If these assumptions and assertions are accepted, then the attitude (strike and dip) of a deformed primary joint or fracture and its trajectory (vertical projection of its line of intersection with the deformed reference surface) can be used as indicators of subsurface structure. If a regular fracture grid is deformed, then fracture density and pattern become important diagnostic parameters. Various patterns of an initially orthogonal (square) fracture grid are modeled according to active and passive deformation mechanisms.

In the active periclinal structure with a vertical axis, fracture frequency (number/unit area) increases both over the dome and basin, and remains constant with decreasing depth to the structure. Active cylindrical folds with horizontal axes deform the initially orthogonal fracture grid, producing a grid trajectory pattern elongate in a direction parallel to the fold axis and causing a relative increase in fracturing for that fracture direction forming the smallest angle to the structural axis. Where one of the fracture directions coincides with the structural axis, a rectangular pattern develops; rhomboid and rhombus patterns are produced for oblique intersections.

For passive periclinal features such as a reef or sand body with a reference grid on the unconformity, fracture frequency is determined by the arc of curvature and shows a reduction over the reef mound and an increase over the basin. In addition, depth to the structure also influences fracture frequency, causing a relative increase with increasing depth of erosion over a reef and a decrease for the basin. Passive cylindrical folds produce a grid pattern elongate in a direction perpendicular to the fold axis, with the fracture direction forming the largest angle to the structural axis being preferentially enhanced. The pattern is rectangular where the structural axis and one of the fracture directions coincide, and forms rhomboids and rhombuses where the two meet at oblique angles.

Decreasing the dihedral angle between the limbs of the structure further intensifies the changes in fracture frequency and grid shape of the fracture pattern.

AN ANALYSIS OF FRACTURE TRACE PATTERNS
IN AREAS OF FLAT-LYING SEDIMENTARY ROCKS
FOR THE DETECTION OF BURIED GEOLOGIC STRUCTURE

by

Melvin H. Podwysocki

ABSTRACT

Two study areas in a cratonic platform underlain by flat-lying sedimentary rocks were analyzed to determine if a quantitative relationship exists between fracture trace patterns and their frequency distributions and subsurface structural closures which might contain petroleum. Fracture trace lengths and frequency (number of fracture traces per unit area) were analyzed by trend surface analysis and length frequency distributions also were compared to a standard Gaussian distribution. Composite rose diagrams of fracture traces were analyzed using a multivariate analysis method which grouped or "clustered" the rose diagrams and their respective areas on the basis of the behavior of the rays of the rose diagram.

Analysis indicates that the lengths of fracture traces are log-normally distributed according to the mapping technique used in this paper. Deviations from log-normality may be associated with both reef (passive) structures whose "closure" is caused by differential compaction of sediments over the reefs and with basement uplift (active) anticlinal structures. The primary control of fracture trace frequency and log-mean lengths is associated with variations in surficial lithology. This variation may be extracted using trend surfaces and the residuals may be analyzed. Fracture trace frequency appeared higher on the flanks of active structures and lower around passive reef structures. Fracture trace log-mean lengths were shorter over several types of structures, perhaps due to increased fracturing and subsequent erosion.

Analysis of rose diagrams using a multivariate technique indicated lithology as the primary control for the lower grouping levels. Groupings at higher levels indicated that areas overlying active structures may be isolated from their neighbors by this technique while passive structures showed no differences which could be isolated.

ORIGINAL PAGE IS
OF POOR QUALITY